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Evaluation of Some Heavy Metals in Soils around Major Parks in Gombe Town, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors BM and WLD designed and supervised the study. Author MMS wrote the first draft of the manuscript. Author AMS managed the experimental analyses of the study. Authors ZS and AA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The levels of heavy metals (Mn, Ni, Pb, Cr, Zn and Fe in mg/kg) in roadside soils from two main motor parks (Gombe Terminus and Tashan Dukku) in Gombe, Nigeria were assessed with respect to distance from the motor parks. The metals concentrations were determined by atomic absorption spectrophotometry. The results show that iron had the highest concentration in all the soils and can be represented in the following order: Fe > Zn > Pb > Ni > Mn > Cr. The heavy metals concentrations were found to be higher in the roadside soils as compared with the control samples. Thus, the metals concentrations decrease with increase in distance away from the parks.

Keywords: Heavy metals; motor parks; roadside soils.

1. INTRODUCTION

In recent years, advancement in technology has led to high levels of industrialization leading to the discharge of effluents and emissions containing heavy metals into the environment. Sources of heavy metals in soils in urbanized areas mainly include natural occurrence derived

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from parent's materials, and human activities which are associated with activities such as atmospheric deposition, industrial discharge, waste incineration, sludge, fertilizer application in soil, and vehicle exhausts [1]. Natural environments that are close to public motor roads are mostly affected by heavy metals from automobile [2]. The quality of air around the vicinity close to the public motor roads can be affected by the heavy metals in the soil which can generate airborne particles and dust [3]. Cadmium (Cd), Zinc (Zn) and Lead (Pb) which are present in fuel as anti-knock agents were reported to be present in emission from heavy traffic [4,5]. However, it was reported elsewhere that the concentrations of cadmium (Cd), zinc (Zn), lead (Pb) and copper (Cu) decreased within 10 – 50 m from the roadsides [6,7]. The high degree of heavy metals often found in roadside soils is mostly attributed to motor vehicles [8]. Heavy metals such as Cd and Pb if allowed to accumulate in food chain can have adverse effects on human and animal health [9].

In developing country like Nigeria, improved roads accessibility creates a variety of ancillary employment which range from vehicle repairs, vulcanizer and welders to auto electricians, battery charges and other facilitators of motor transportation [8,9]. These activities send trace metals into nearby soils, which are absorbed by plant on such soil [9]. Therefore, the aim of this study is to determine the level of some heavy metals (Mn, Ni, Pb, Cr, Zn and Fe) contamination of roadside soils at different motor parks in Gombe metropolis, the Gombe State Capital.

2. MATERIALS AND METHODS

2.1 Study Area

This study was realized in Gombe, which is located in the north-east part of Nigeria and lies between (latitude 10º08'N and 11º24'N, longitude 11º02'E and 11º18'E.) The annual rainfall ranges from 850 mm-1000 mm with average daily temperature of 34ºC in April and 27ºC in August [10]. The relative humidity ranges between 70-80% in August and drop to between 15-20% in December [11]. The natural vegetation of Gombe is typically that of the Sudan Savannah and is composed of shrubs herbs grasses and sparsely distributed trees.

2.2 Sampling

Samples were obtained in the dry season, 2019, at Gombe mass transport park (Terminus) and Dukku Motor Park in Gombe town (Tashan Dukku). At each sampling point (Fig. 1) about 10 g of the roadside soil was collected at surface level at a distance of 20 m away from each point on the road. A soil control sample at each point was also collected from a site about 50 m away from the sampling points, bearing in mind that the distance from the road will make them to be less exposed to the pollutants. Five samples were collected in each point, thoroughly mixed in a clean plastic container to obtain a representative sample, stored in new polythene bags, sealed and properly labeled for easy identification prior to analysis.

2.3 Sample Preparation for Heavy Metals Determination

Analytical grade reagents were used for all analysis. The data used in this assessment were obtained by analyzing the soil samples with a PerkinElmer A Analyst (p/n no 410025) 300 atomic absorption spectrophotometer. The size of each large clod was first reduced and the sample was spread on a tray in a layer not thicker than 15 mm. Thereafter, the various samples were placed in a drying oven at a temperature of 40°C. They were left in the oven for 24 hours to remove the moisture in the samples. Each oven-dried sample was crushed into particles and passed through a 2 mm sieve [12]. However, before crushing commenced, stones, fragments of glass and other noticeable impurities were removed by hand. A 1 g of each soil sample was accurately weighed and treated with 10 ml of high purity concentrated HNO_3. The mixture was placed on a hot plate until it became dry. It was then cooled [12]. This procedure was repeated with another 10 ml aliquot of

Table 1. Sampling locations

S/N	Sample location	Designation	Control sample location
1	Gombe mass transport park (Terminus).	A1, A2, A3, A4, A5, B1, B2, B3, B4, B5	Residential area C1 and C2
2	Dukku motor park Gombe town (Tashan Dukku).	D1, D2, D3, D4, D5, E1, E2, E3, E4, E5	Residential area C3 and C4

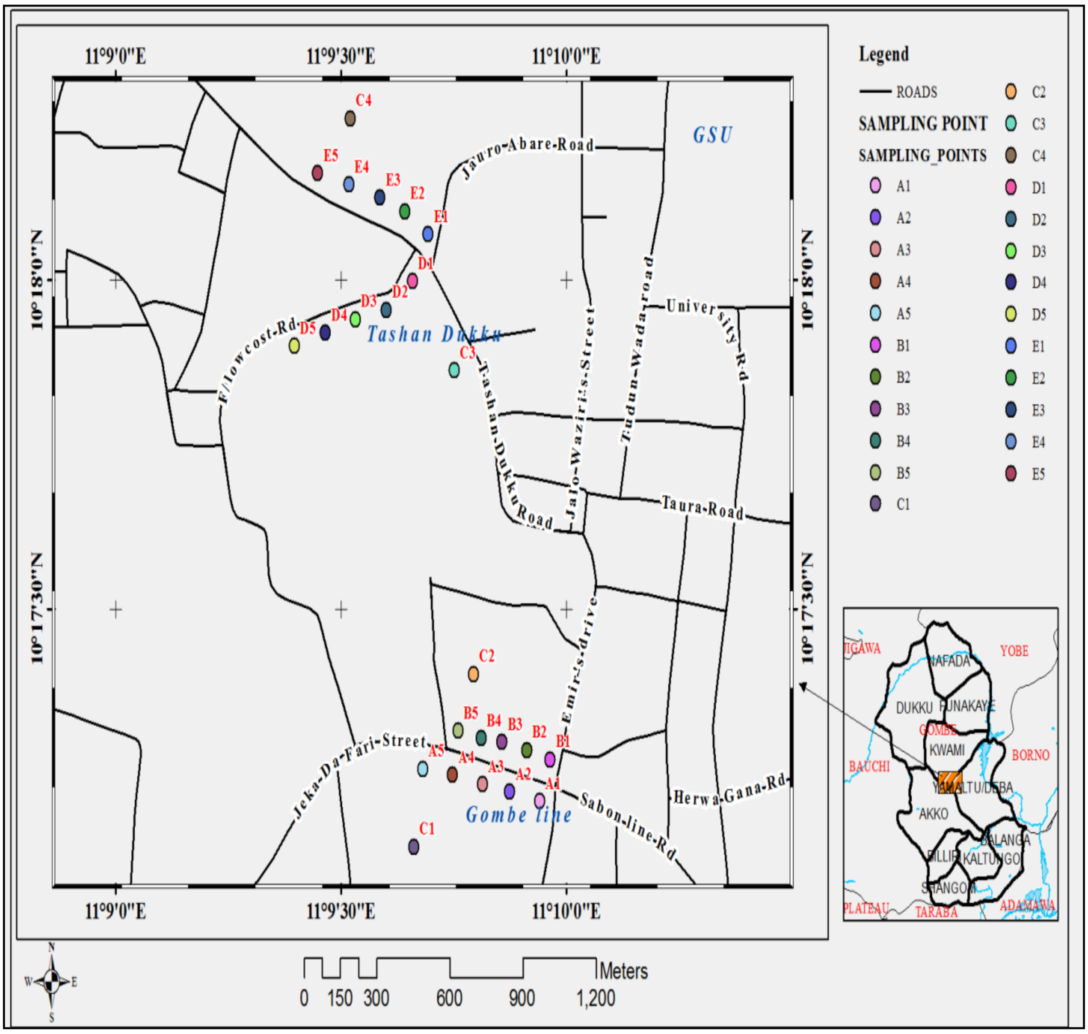

Fig. 1. Map of Gombe town showing sampling points

Concentrated HNO_3 followed by 10 ml of 2 M HCl. Each digested soil sample was then warmed in 20 ml of 2 M HCl to redissolved the metal salts [12]. The extract was filtered with filter papers and the volume was then adjusted to 25 ml with double distilled water. The digested samples were then stored in a sampling box for analysis. The data obtained were analyzed using ANOVA single factor in excel 2016.

3. RESULTS AND DISCUSSION

The heavy metals concentrations in the roadside soils and soil control sample are presented in Table 2 with sample A, B, D and E having C1, C2, C3 and C4 as control samples respectively. The concentration of Pb in the samples ranges from 10.29-13.06 mg/kg while, the control samples ranges from 0.41-0.87 mg/kg. Lead concentration was found to be in the following trend E>D>B>A based on the results obtained from the soil samples. This implies that sample E, has the highest concentration which may be due to deposition from automobile exhaust, garbage disposal, discarded batteries, filling stations, motor parks and other lead bearing materials.

Mn and Zn concentrations were found to be within the range of 2.60-3.45 mg/kg, and 18.41-27.37 mg/kg respectively. However, the obtained results are higher than the control samples. The above heavy metals are among the wide range of heavy metals found in fossil fuels, which are either emitted into the environment as particles during combustion or accumulate in ash, which may itself be transported in air and contaminate soils. Furthermore, Ni concentrations were obtained to be in the range of 5.08-7.18 mg/kg (Table 2). This could also be attributed to deposition of sewage sludge, dispose car batteries, pigments and paints, poultry waste and

Table 2. Heavy metals concentration in the Gombe motor parks roadside soil

	Elements/mg/kg					
Samples	**Cr**	**Ni**	**Mn**	**Pb**	**Zn**	**Fe**
Sample A	0.08	5.69	2.95	10.29	19.03	49.16
Sample B	0.06	5.08	2.60	10.47	18.41	53,04
Sample D	0.11	7.18	3.45	13.06	27.37	68.19
Sample E	0.10	6.11	3.13	14.67	23.93	64.33
Control sample C1	0.02	0.19	0.01	0.43	1.33	3.48
Control sample C2	0.01	0.11	0.01	0.41	1.21	4.17
Control sample C3	0.04	0.31	0.03	0.86	1.50	7.32
Control sample C4	0.04	0.26	0.02	0.87	1.98	7.89
p values	0.19	0.98	0.97	0.98	0.99	0.99

fossil fuel combustion. This concentration of Ni will end up in the soil when they are leached and can dissolve in soil water and in rivers as a result of run off during wet season. The concentration recorded for Cr, falls within the range of 0.06-0.11 mg/kg. These concentrations can be as a result of dumping of chromate wastes, such as electroplating and from sewage sludge disposal on the land. Fe concentrations in the soil samples were recorded from 49.16-68.19 mg/kg. Although Fe is not classified as a toxic metal, its concentrations and chemical form can influence the speciation of Pb and its toxicity. It is of interest to note that, the concentration of heavy metals in the control samples are lower than the concentrations of heavy metals found in the soil samples. Gombe town is not industrialized, however, like most of the towns and cities in Nigeria it is traffic-laden due to congested traffic (especially along Gombe Terminus road), and outdated automotive technology contributed to the increase in vehicular emissions which could be deposited along the road and thereby accumulate to pollute the environment.

The concentration levels of Mn, Ni, Pb and Cr found in this study were lower than the European Commission (EC) limit of 1500 mg/kg, 50 mg/kg, 300 mg/kg and 100 mg/kg respectively [13]. The levels of manganese in soils were relatively low. It was also observed that the concentrations of manganese obtained in this study are lower than the results obtained in Yauri [14] (608.11 mg/kg) and Kaduna [15] (132 mg/kg). Similarly, the concentrations of Mn in this research are also lower than the concentration recorded in the United States (2532 mg/kg), China (1740 mg/kg), and Poland (1122 mg/kg) [16-18]. Mn and Ni are associated with traffic related sources [19,20]. The heavy metals concentrations in the soil samples are higher due to human activities and traffic volume than those in the soils for control samples. Thus, the concentration of heavy metals decreases with distance from the road due to metals emitted from vehicle exhaust and other sources.

4. CONCLUSION

The levels of heavy metals concentration (Mn, Ni, Pb, Cr, Zn, and Fe) in roadside soils from two main motor parks in Gombe, Nigeria were determined. The results show that iron had the highest concentration in the soil and can be represented in the following order: for site A; Fe > Zn >Pb > Ni >Mn >Cr, For Site B; Fe > Zn >Pb > Ni >Mn >Cr, For Site D; Fe > Zn >Pb > Ni >Mn >Cr, For Site E; Fe > Zn >Pb > Ni >Mn >Cr. The heavy metals concentrations in the roadside soils samples are mostly higher than those in the control samples due to metals emitted from vehicle exhaust and other sources. The concentration of all the heavy metals in the two locations were below that of the European Union regulatory standard.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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